USING RENEWABLE ENERGY FOR RURAL CONNECTIVITY AND DISTANCE EDUCATION IN LATIN AMERICA*

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ABSTRACT

Throughout Latin America, rural connectivity is a topic of increasing interest. Country governments, non-governmental organizations, and the private sector are all teaming to bring a variety of innovative programs to rural areas that provide services such as telephony, distance education, and access to the internet. Photovoltaic (PV) technologies are helping to bring these services to the more isolated communities located beyond the electric grid. Sandia National Laboratories and its partners are facilitating the increased use of PV for these new and growing applications through capacity building and technology development, with emphasis on Mexico and Central America. The work described herein is sponsored by the U.S. Agency for International Development (USAID) and the U.S. Department of Energy (USDOE).

INTRODUCTION - THE VALUE OF RURAL CONNECTIVITY

Many programs in the developing world are designed to help improve the quality of life for poorer populations in remote areas. Traditional activities often include the provision of health, education, and other community services. Of recent and growing interest is the use of information and communication technologies (ICTs) in helping to meet the goals of these rural development programs. ICTs span a broad range, from telephones and computers to more complex systems, such as internet connectivity through radio links or very small aperture terminal (VSAT) satellite links. Several factors are driving these developments, including technical advances and cost reductions in rural telecommunications, reforms in the telecommunications sector bringing in new players and partnerships, and the existence of proven rural distance education models that are available to be replicated.

There are several ways in which the appropriate application of ICTs can facilitate rural development efforts. These include [1]:

- Improved educational services and distance education: providing access for teachers and students to a broad menu of educational materials and even educational programming.
- Access to information for economic development, such as small business accounting, weather trends and farming best practices, and timely access to market information regarding where to sell products and at what prices.
- Improved health care, through remote consultation, diagnosis, and treatment; relevant medical training for remote providers; improved disease prevention and epidemic response capabilities; and dissemination of public health messages.
- Local empowerment and democratic participation through e-governance, for example, by providing access to information on issues and facilitating voting processes.
- Cultural and indigenous knowledge preservation.
- Improved disaster mitigation and response capabilities, through improved communications.
- Access to world-wide markets via the internet for specialty products such as indigenous music and crafts.

Several in-country programs are using ICTs in their efforts to improve the quality of life in rural Latin America. The use of ICTs in distance education programs is generally more established, while other applications are being developed and continually improved. For instance, the Mexican *Telesecundaria* program brings satellite-based distance education programming to students in grades 7-9 in more than 20,000 schools across Mexico [2]. Throughout Central America, analogs of the *Telesecundaria* program are being implemented as pilot activities in more than 500 rural schools. The Peruvian government recently introduced its *Plan Huascaràn,* in which it plans to bring distance education to 5000 schools. In the area of rural connectivity, the government of Honduras has secured a loan from the Inter-American Development Bank for partial financing of an $8 million rural connectivity program that will link at least a hundred rural communities. Similar pro-

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grams are either under development or underway in countries throughout Latin America.

What often lacks in these programs, however, is a clear understanding of the value that PV and other renewable energy technologies can have in bringing these services to more isolated populations when coupled with the technical capacity to properly implement PV-powered projects. In the majority of these projects, what is called “rural” still requires connection to the electric grid. For example, in the existing Mexican program, only about 400 schools are PV powered, leaving thousands of villages unsupported by the program. In Central America, where almost half the population of 35 million lives off-grid, less than a dozen rural distance education schools are off-grid. And within Peru’s ambitious *Plan Huascarán,* only 1000 of the planned schools will be off-grid, while several thousand Peruvian communities do not have grid electricity. While other rural connectivity initiatives are just getting started, they run similar risks of not reaching the more remote communities.

In working to introduce PV and other renewable energy technologies into these programs, a broad team has been assembled, comprised of Sandia National Laboratories, Winrock International, Southwest Technology Development Institute of New Mexico State University, and Enersol Associates. Additional key contributions are provided by several in-country partners, including Ecoturismo y Nuevas Tecnologías (Mexico), Adesol (Honduras) Fundación Solar (Guatemala), FUNRURAL (Guatemala), and the ministries of education in each country. Additional collaborative support has been provided by the Organization of American States (OAS).

PV FOR DISTANCE EDUCATION IN MEXICO AND CENTRAL AMERICA

The multi-institutional team described above has been working with partners in the ministries of education in Mexico, Guatemala, and Honduras to demonstrate the viability of PV for expanding their distance education networks. In Mexico, this has entailed an assessment of problems and issues with previously installed PV systems, preparation of guidance materials and technical specifications, and the development of plans for further utilization of PV. In Guatemala and Honduras, these same materials have been used in conjunction with the implementation of USAID-sponsored pilot projects through which quality techniques have been applied and demonstrated.

Beginning in mid-year 2000, the Mexican Secretariat of Public Education (SEP) and Sandia have collaborated on the following technical and infrastructure activities [3]:

- Technical assessments of previously installed PV systems to identify existing shortcomings that must be fixed;
- Development of PV system specifications for design, installation, and follow-up maintenance;
- Better load management through new efficiency practices and the use of energy efficient appliances;
- Capacity building of vendors and technicians via workshops and field training on PV design, procurement, installation, operation, and maintenance; and
- Monitoring of fielded systems.

In an on-site assessment of several PV powered Telesecundarias in the state of Durango, several problems with fielded PV systems were identified. Correcting problems with existing installations is an important first step towards the broader adoption of PV technology for rural schools in Mexico. Some of the installation-related problems encountered include undersizing of cables, PV system undersizing, improper orientation of the panels, incorrect types of batteries, high energy consuming loads (e.g., inefficient TVs), and lack of end-user knowledge on the proper use and care of the system. These issues are being addressed through the capacity building activities for SEP technicians, local teachers and community leaders, and for suppliers and installers of PV systems.

The principal conclusions from the study are that there is now little standardization in system design, even though the uses and loads across many schools are the same, and that PV systems are typically undersized for the loads present. The lack of standardization points to a largely decentralized procurement scheme for power systems. Although SEP centrally procures, installs, and maintains the satellite reception equipment at a rural school, it is often the responsibility of the individual community to provide power. This makes quality control difficult, and provides no incentive for SEP to use energy efficient equipment, since they do not pay the bill for the power system. One solution is for SEP to expand its responsibility to include the power system as part of the educational system in off-grid applications. Another is to work with procurers and suppliers to ensure that they provide high quality system designs and installations.

These latter approaches are being employed in Guatemala and Honduras, where the distance education programs are at much earlier stages, and Sandia has teamed with local partners to implement pilot PV systems that demonstrate these principles. With USAID support, the ministries of education in each country have piloted their own versions of distance education programs. Guatemala has almost 400 participating rural schools, while Honduras has thirty-six. In each country, a pilot PV installation and associated capacity building workshops have helped to raise local awareness of the potential for PV to help extend the reach of these new programs. This is a significant potential: in Honduras alone, there are more than 2000 unelectrified schools.

Figures 1 and 2 show a typical rural school in Guatemala, located in the community of La Concha, where the pilot installation and training was conducted. This school is actually run by a private foundation called FUNRURAL, which was a key partner in the project implementation. Figure 2 shows the students watching the educational programming provided by videotapes.

Figure 1: Site of the PV for distance education pilot project in La Concha, Guatemala.

Figure 2: Students watching educational video programming in La Concha, Guatemala.

The installation in La Concha includes two independent PV power systems for grades 7 and 8, with plans to add another system for grade 9 later. As in the Mexican scenario, the PV system provides enough energy to allow 15 minutes of video programming on a 27-inch color television during five class periods each day. In addition, the system provides power for several efficient fluorescent lights installed in the classroom.

PV FOR RURAL INFORMATION AND COMMUNICATION TECHNOLOGIES

As was stated in the discussion on distance education, many of the same limitations exist in relation to energy needs and the application of ICTs for the more remote populations in developing countries. An improved understanding of PV and other renewable energy technologies can greatly expand the utility of such systems through extending their applicability to more remote areas. This is especially enhanced by the fact that several different wireless technologies are available for remote communications, depending on the level of service needed and the budget available.

The organizations represented by the authors of this paper have conducted some innovative initiatives related to the provision of energy for rural ICTs in developing countries, with the intent to develop testbeds and models for broader replication. For instance, by equipping un-electrified schools in rural areas of the Dominican Republic and Honduras with solar-powered computers and educational software, Enersol, a private, non-profit organization, is helping to provide advanced educational tools to rural areas. While working closely with the teachers and community leaders to assure the long-term technical viability of the energy and computing systems, Enersol is obtaining valuable information about energy usage as well as the types of materials that are most useful in helping the students develop new computing skills.

Winrock International has recently led an assessment of opportunities for rural ICTs for development applications in several Latin American countries, on behalf of the Inter-American Agency for Cooperation and Development of the OAS [4]. The study was focused on opportunities in Guatemala, Belize, Honduras, Columbia, Bolivia, and Peru. Sandia National Laboratories and New Mexico State University provided technical assistance to the effort. In this study, Winrock identifies several constraints to the adoption of rural ICTs in a developing country context. These include:

- The lack of electricity in many rural areas;
- Rural internet connectivity is often slow, expensive, or unreliable;
- The lack of trained or experienced personnel to operate and maintain systems;
- Many competing needs for scarce resources (water, health, education); and
- Low rural incomes limit cost recovery.

In addressing these pitfalls, the study defines several rural “telecenter” configurations and discusses energy requirements for each. These configurations include:

- a single remote telecenter, with no connectivity;
- a single telecenter with a satellite terminal connection;
- a remote telecenter connected to a central location through a wireless communication scheme; and
- a central telecenter serving as a wireless internet service provider to other mini-telecenters within a 17km radius.

The telecenters modeled in this study range in total cost, including connectivity and energy equipment, from approximately $6,000 to $78,000. While the cost is dependent on overall size and population served, another key factor is the decision to use desktop PCs versus laptop computers. Although in most cases PCs are less expensive than laptops, their higher energy consumption leads to the need for more expensive energy systems. Factors that a developer of a rural telecenter must consider include:

- Price of hardware, software and peripherals;
- Usability in a telecenter environment, including ruggedness and susceptibility to theft;
- Energy consumption;
- Warranty, maintenance, and repair services; and
- Dealer incentives, such as bundled software packages.

The results of this study are presently being applied in Honduras, where Winrock, Sandia, and NMSU are assisting the World Bank Energy Sector Management Assistance Programme (ESMAP) in the implementation of several pilot rural telecenters. ESMAP has partnered with several government and non-government organizations in Honduras on these projects, including Hondutel, the national telecommunications company, and the United Nations International Telecommunications Union. These rural, PV-powered telecenters will serve as models for a broader Honduran program sponsored by the Inter-American Development Bank, through which more than 100 rural communities will receive some form of connectivity.

Similar efforts are underway in other Latin American countries, including Columbia, Bolivia, Brazil, and Peru. In all of these cases, the implementers of these programs will benefit from a deeper knowledge of the capabilities and cost effectiveness of PV in remote applications. This knowledge will allow them to visualize reaching out to the more remote communities in their countries, and doing so in a manner that is cost effective and technically viable over the long term.

CONCLUSIONS

The partnered activities described herein are designed to produce growing impacts over time and have already led to some valuable results that indicate this trend. In Mexico, SEP is using their new technical specification in the procurement of several hundred new PV systems for distance education schools. This is the start of what could lead to several thousand PV-powered schools in Mexico. Similar pilot installations in Honduras and Guatemala have led to the development of new strategies and proposals to extend these capabilities to the more remote populations in these countries.

Similarly, with rural connectivity, PV will play an important role as the field continues to grow and satisfy the huge unmet global demand. As in many other early adoptions of PV, the rate of growth of this new market will partially depend on the success of early installations, in terms of ease of installation and operation, long-term functionality, and overall cost effectiveness. By internalizing energy considerations as part of the planning process from project initiation, future replications will be based on well-developed models that will demonstrate the value and feasibility of using PV to provide connectivity to more remote off-grid populations.

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